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Overview of the Development of Australian Combat Ration Packs

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ABSTRACT

The introduction of continual product improvement—whereby items are replaced or reformulated depending on feedback from soldiers and sensory evaluation of specific foods and beverages—has led to a steady improvement in both the nutritional quality and acceptability of combat rations. In addition, prototype ration packs have been developed for specific purposes and include light-weight rations, hot climates rations, and modular rations. Combat rations remain vital to the performance of our soldiers during training, on field exercises and on operations. Continued research in Defence food and nutrition is essential to ensure that ADF members are provided with combat rations that deliver the nutrition required to sustain optimal cognitive and physical performance.

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Overview of the Development of Australian Combat Ration Packs

Executive Summary

Combat ration packs (CRP) have improved to the point where Australian Defence Force (ADF) members are now supplied pre-packaged meals that:

- meet their basic daily energy needs
- provide an appropriate mix of macronutrients (protein, fat and carbohydrate);
- meet food safety standards
- are sealed in robust packaging
- have a long shelf life
- can be readily stored and transported, and carried by troops in the field
- are convenient, as they require minimal preparation in the field.

The Defence Science and Technology Organisation (DSTO) has responded to requests from the ADF to design and develop new types of ration packs for specific purposes. Three particular themes have been explored:

1. A light-weight ration pack (LWRP) for short-duration use.
2. Hot-climate ration packs (HCRP) for use in tropical and desert climates.
3. Modularised ration packs (ModRP) for better matching ration packs to the physical activity levels of the operations being undertaken.

Recent research has led to a good understanding of the dietary needs of military personnel and how these vary with the nature of the activities undertaken and with the environmental conditions under which troops operate. Ration designers are also better able to take into account the less tangible 'human preference' effects of taste, appearance, convenience and societal eating norms when developing or revising combat rations.

Combat rations remain vital to the performance of our soldiers in the field. Continued research in Defence food and nutrition ensures that the ADF is provided with combat rations that deliver the right nutrition for sustained cognitive and physical performance over the complete range of military operations.

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Acronyms

ADF	Australian Defence Force
CR1M	Combat Ration One Man
CR5M	Combat Ration Five Man
CRP	combat ration packs
DSTO	Defence Science and Technology Organisation
EER	estimated energy requirement
EFR	Emergency Flying Ration
ER	Emergency Ration
HCRP	Hot-Climate Ration Packs
LWRP	Light-Weight Ration Pack
MES	Modular Energy System
ModRP	Modularised Ration Packs
MRE	Meal, Ready-to-Eat
NATO	North Atlantic Treaty Organization
PAL	physical activity level
PR1M	Patrol Ration One Man
S&T	science and technology

1. Introduction

Combat ration packs (CRP) for the military have improved to the point where members of the Australian Defence Force (ADF) are now supplied pre-packaged meals that:

- meet their basic daily energy needs
- provide an appropriate mix of macronutrients (protein, fat and carbohydrate);
- meet food safety standards
- are sealed in robust packaging
- have a long shelf life
- can be readily stored and transported, and carried by troops in the field
- are convenient, as they require minimal preparation in the field.

However, significant challenges remain. Paramount amongst these is 'field stripping',[1] i.e. the frequent discarding of items from the ration packs, resulting in a reduction in their nutritional efficacy and unnecessary waste. Related to the stripping of ration packs is their substitution with non-issue food items referred to as 'jack rations'. A variety of factors appear to be responsible, ranging from individual taste preferences, through aesthetics of the packaging to the convenience with which ration pack items can be carried and consumed.

There are also psychological effects associated with choice of foods and the act of eating that are considered important, but are yet to be adequately addressed.[1] Ongoing research by the Defence Science and Technology Organisation (DSTO) supports a continual product improvement approach to CRP and delivers improvements in meeting the nutritional needs of ADF personnel.

2. Military Nutritional Requirements

Providing appropriate nutrition to military personnel is critical, as nutritional status can directly influence physical and cognitive performance during military operations. In the longer term, poor nutrition leads to deterioration in the health and wellbeing of military personnel.[2-4] Specifying military nutritional requirements is, however, problematic owing to the diverse and specialised nature of military operations. For example, the energy needs for some Special Forces activities (25 MJ per day or more) is similar to those of polar explorers.[5, 6] At the other end of the scale, the daily energy needs of submariners are only about half this,[5] more closely matching those of office workers.[5, 7]

A single numeric value, specified in terms of an 'average' person, is not particularly useful for describing the overall daily energy requirements of individual humans.[7, 8] Since 1935

groupings based on age, gender, body type and physical activity have been used to capture the daily energy requirements for human populations, but even for individuals in the same category there can be significant differences.[8] Measurements suggest that the variation in energy expenditure from one person to another can be 25% or more.[9]

To determine the typical nutritional requirements of humans, broad groupings in terms of age, gender and activity have proved useful.[8] Age and gender are clearly defined but 'activity' is a less definitive term. To quantify activity, a physical activity level (PAL) scale is used.[7, 10] PAL is defined as the mean daily energy expenditure divided by basal metabolic rate. This scale provides a convenient means for addressing variations in nutritional requirements in terms of types of activities undertaken and can be broadly related to jobs and lifestyle.[7]

The PAL scale can be used for establishing energy requirements for various military groups and activities.[5] Table 1 shows the relationship of PAL to indicative daily estimated energy requirement (EER) and examples of civilian and military jobs that relate to each PAL.[4, 5, 7, 11, 12] Five categories can then be constructed to encompass a wide range of military activities.[5, 13]

A useful international yardstick for establishing nutritional requirements for military personnel (and hence their rations) is the NATO Response Force (NRF). This is described as a highly-ready and technologically-advanced rapid-response group of land, air, sea and Special Forces components.[11] For establishing nutritional requirements, the missions of the NRF are seen as falling into two categories:

- Normal operations, considered to be those missions comparable to urban police, fire fighting or construction work. Such operations are assigned a PAL of 2.0 with an energy expenditure of ~ 15.0 MJ/day.
- Combat operations such as missions involving sustained, dismounted light-infantry or Special Forces. These are assigned a PAL of 2.6 with an energy expenditure of ~ 20.5 MJ/day.

Table 1. Relationship of PAL to civilian lifestyles and military jobs with indicative total energy expenditures

Category	Description	PAL	Civilian	Military	EER (MJ/day)
0	Inactive	1.2	Elderly or invalided patient		9.5
1	Sedentary	1.4	Male office worker, urban lifestyle		11.0
2	Light activity	1.6		Submariner	12.5
3	Moderately active	1.75	Construction worker	Sailors (frigate)	13.5
4a	Highly active	1.9		Naval recruits	15.0
4b	Vigorously active	~2.2	Manual agricultural labourer	Soldiers (infantry)	~17.0
5	Extremely active	2.4+	Tour de France - cyclist	SASR candidates	19+

Notes:

a. Table developed by the authors using the following sources:[5, 7, 10, 11, 12, 14]
b. EER values are given as a guide only. They will vary with prevailing environmental conditions and from one person to another.

3. Development of Australian CRP

Although emergency rations existed from the time of the Boer War, Australia did not have a purpose-designed CRP until late in World War II. The O2 operation ration, developed in 1943, may be considered the forerunner of the modern CRP as it aims to satisfy four primary requisites: nutritional value and balance, stability when stored and transported under challenging conditions; packaging for convenience and carriage; as well as palatability.[15-17]

Plastic and metal foil laminate retort pouches were developed for CRP to provide a lighter-weight and more flexible option to the traditional metal can. The Meal, Ready-to-Eat (MRE), based on this new technology, was prototyped in the US in 1970 and introduced into service there in the 1980s.[12] Retort pouches were adopted for use in the Australian Combat Ration One Man (CR1M) in the early 2000s.

An important technology for Australia is freeze-drying. This produces light-weight, high-energy, processed meals that are then vacuum-sealed in a metal-foil pouch in which the meal can be heated over a flame stove. Freeze-dried meals are not only light-weight, convenient and provide high levels of energy, they are also nutritious and better retain the taste and texture of the original food.

The introduction of continual product improvement concepts has seen the steady improvement of CRP, where items are replaced or upgraded depending on feedback from soldiers and sensory evaluation of specific food and beverage items. A summary of the evolution of Australian combat rations is captured by Figure 1. For a fuller history of Australian combat rations see Ormston (2013).[18]

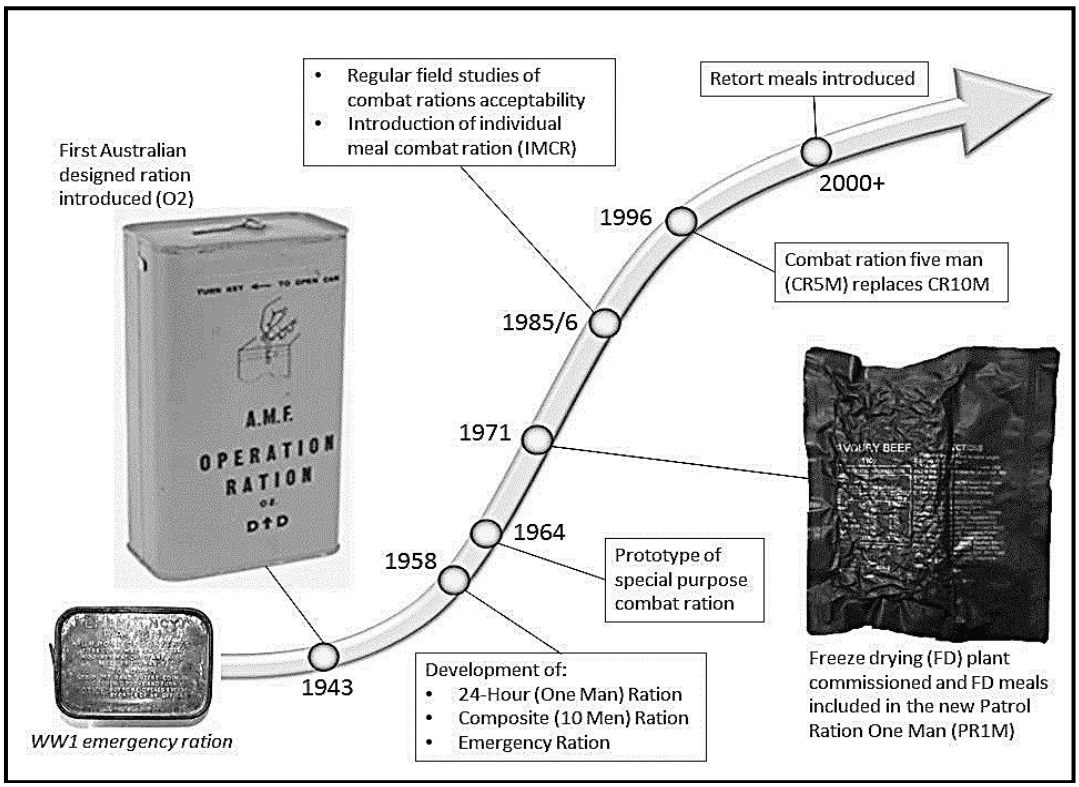

Figure 1. Evolution of Australian Combat Rations.

4. Australian Combat Rations Today

Today's Australian CRP include the Combat Ration One Man (CR1M) and Patrol Ration One Man (PR1M) for individual use and the Combat Ration Five Man (CR5M) for group feeding. In addition, Emergency Combat Rations which include Emergency Ration (ER) and Emergency Flying Ration (EFR) are also designed for individual feeding. CRP are designed to be nutritionally adequate for 'very active' personnel.[5] The CR1M, PR1M and CR5M thus aim to provide approximately 16 MJ per person per day; while the ER and EFR provide 2.4 MJ and 6.3 MJ per pack respectively.

There are eight menus of CR1M and five menus each of PR1M and CR5M. Each menu includes main courses, a snack or light meal, confectionery, beverages, spreads and condiments. Table 2 provides a summary of food items by group for each type of CRP.

Table 2. Types of foods provided in CRP[19]

Types of foods	Combat Ration Packs			Emergency Combat Rations	
	Individual feeding		Group feeding	Individual feeding	
	CR1M	PR1M	CR5M	ER	EFR
main meals and rice (flexible retort pouch or freeze dried)	flexible retort pouch meal	freeze dried meal	flexible retort pouch meal		
light meals (soup, noodles, steak bar, canned fish)	✓	noodles	steak bar, canned fish		
cereal (biscuit, cereal bars)	✓	✓	✓		✓
dairy (processed cheese, sweetened condensed milk, skim milk powder)	✓	sweetened condensed milk	processed cheese, sweetened condensed milk		skim milk powder
dessert (canned fruit, pudding, fruit bars, fruitcake)	canned fruit, fruitcake	fruit bars	canned fruit, puddings		
drinks (beverage powders, coffee, tea)	✓	✓	✓		✓
confectionery (ration chocolate, chocolate candy, hard candy various, chewing gum)	ration chocolate, chocolate candy	ration chocolate, chocolate candy, candy various	ration chocolate, chocolate candy	ration chocolate (x2)	ration chocolate, chocolate candy
vegetables (potatoes, peas, carrots, corn, baked bean)			✓		
Spread (yeast extract, fruit jams, spreads)	✓	yeast extract	✓		
condiment (salt, sugar, curry powder, pepper, sauces)	salt, sugar, pepper, sauces	salt, sugar, pepper, sauces	✓		sugar

Note:

✓	Represents all components in the group, otherwise individual components are listed.
	These ration packs do not cater for consumers with any food allergy or special dietary requirements.

A look at the composition of CR1M since 1986 reveals that substantial changes have occurred in both composition and total energy content. Table 3 shows how the mean total energy provided by the CR1M has increased since 1986. Also, the variety has been increased through expanding the number of menus from five to eight.

Table 3. Changes in CR1M since 1986

Build*	No. of Menus	Measured energy content (MJ)	Energy requirement (MJ)
1986/87	5	12.4[20]	13 a[21] 14.4 b[21]
1994/95	5	13.5 (DSTO unpublished data)	15 c[20] 15–17 d[22]
2000/01	5	15.9 (DSTO unpublished data)	15–17 d[22]
2012/13	8	18.9[23]	15 e[24] 16 f[5]

Notes:

*	Build = year of assembly of CR1M
a	Table 2 Nutrient requirements of reference 70 kg man per day, grade 2 level of activity "moderate"
b	Table 2 Nutrient requirements of reference 70 kg man per day, grade 3 level of activity "strenuous"
c	Table 1 Nutrient requirements of 25 year old, 75 kg man per day, grade 2 level of activity "moderate" and grade 3 level of activity "strenuous" had values of 13.8 MJ and 16 MJ respectively.
d	Table 4 Recommended daily dietary intakes for servicemen according to activity level, category 3 level of activity "very active"
e	Based on category 3 level of activity "very active"
f	Table 9 Recommended nutritional criteria for general purpose ration packs, category 3 level of activity "very active"
g	Note that the system for categorising energy requirements has changed since the 1980s and direct comparisons are not readily made (see notes to Table 4)

The 12.4 MJ energy value of the 'revised' CR1M introduced in 1986/87 represents a low point in the energy content of CRP.[20, 25] This resulted from replacement of some unpopular components with more acceptable ones, use of leaner cuts of meat and improved manufacturing, and serves to illustrate the challenges faced in improving CRP.[20] By 1994/95 the energy content had been significantly increased and by 2000 the CR1M again met requirements (Table 3).

More recently CRP with an energy content of 19 MJ have been supplied which provide more energy than required on typical field exercises.[5, 23] On the positive side a higher energy content provides a surplus to offset the discarding of some components thus decreasing the risk of reduced physical and cognitive performance. On the negative side, it increases load carriage and encourages waste.

The weight of the main meals has increased significantly. The quantities of cheese, chocolate drink, soup, ration chocolate and sweetened condensed milk have also increased. Along with the introduction of chocolate candy, steak bar, cream spread, all-fruit bars, muesli mix, tuna and sports drinks this has increased the weight of CR1M. Some

small offset has occurred with a reduction in the quantity of sachet salt, and ~ 33% reduction in sugar in 2000 followed by a further reduction of 50% ten years later.

The increase in portions has led to an increase in volume as well as weight. CR1M and PR1M are individually packaged in clear polythene bags, with five bags being packed into a rectangular metal can. Tellingly, it was necessary to increase the size of the metal can in the mid-1990s to accommodate the growing bulk of individual ration packs.

While packaging adds to the weight carried, it is critical for achieving long shelf-life and retaining the quality of food items. Commercial-grade packaging typically only needs to protect food for short periods and under the controlled transport and storage conditions used by supermarkets. In contrast, military food packaging must be physically robust and have excellent moisture and oxygen barrier properties to retain the integrity and quality of the food until the soldier consumes it. During the interval between manufacture and consumption, a CRP may be subjected to harsh environments—with wide variations in temperature and humidity—and physical stresses while being transported. The packaging is as critical to the quality of the rations delivered as is the type and processing of the food at the time of manufacture.

The shelf life is dependent on a number of factors including type of food or beverage, processing conditions, moisture content, storage conditions and properties of the packaging. CRP are specified to be shelf stable for 24 months from the date of acceptance by the Defence Materiel Organisation (DMO).[26] The shelf-life achieved is, however, largely dependent on the environmental conditions under which CRP are transported and stored (Table 4).

Table 4. Shelf-life and duration use of CRP

Ration Pack Type	Storage condition (months)[26]		Duration of use (days)[19]		
	Temperate climate	Tropical climate	Non-Operational	Operational	Emergency
CR1M	33	27	16	20	as necessary
CR5M	33	27	16	42	as necessary
PR1M	42	36	16	as necessary	as necessary
ER/EFR	33	27	not specified	not specified	as necessary

5. Prototype Ration Packs

DSTO has responded to many requests from the ADF to explore new types of ration packs for specific purposes. In addition to developing concepts and outline designs, some prototypes have been constructed and tested in field trials. Three particular themes have been explored:[27-29]

- A light-weight ration pack (LWRP) for very short-duration use.
- Hot-climate ration packs (HCRP) for use in tropical and desert climates.
- Modularised ration packs (ModRP) that are based on modules that can be assembled in various combinations.

5.1 Light-weight ration pack (LWRP)

Minimising the load carried by troops is a perennial goal that is increasingly challenging as advances in technology provide more devices for a soldier to carry. It is thus important to design rations that deliver the required nutrition in as small and light a pack as possible. Recently a requirement was developed for 24-hour, individual LWRP that would:[28]

- weigh ≤ 800 g
- provide at least 10 MJ energy
- be suitable for use for up to five days in situations not demanding high levels of physical activity
- contain ready-to-eat foods that do not require preparation
- provide sufficient nutrition to maintain satisfactory levels of physical and cognitive performance
- not adversely affect longer-term health
- have adequate acceptability.

Table 5 is a broad outline for such a LWRP which meets or exceeds these requirements. While the recent focus was on a 24-hour ration pack, there had been earlier work on a 72-hour LWRP where the overall weight for three days of rations was reduced further as any utensils were to be reused each day (Figure 2). LWRP packs could, depending upon the shelf-life required, be based on commercially-available processed meat, energy bars, dried fruit, biscuits and sports gels and protein or sports drink powders.

In calculating the feasibility of the LWRP as specified above, the following considerations were taken into account:

- weight of packaging and utensils is ~50 g; therefore total weight of food is ~750 g.

- being ready-to-eat, average moisture content would be in the range of 10-20% to keep the weight down.
- another 5% (approx.) of weight will be in the form of minerals (especially salt) and dietary fibre.
- some energy is derived from dietary fibre as a result of bacterial action. Estimates on this vary but 13 kJ/g could be made available, well above the typical 8 kJ/g allowance for dietary fibre.
- assuming ~15 g of dietary fibre, an additional ~200 kJ may be derived from this source.

Table 5. Broad specification and nutritional value for a 24-hour LWRP[28]

Characteristic	Weight (g)
Total weight of pack	800
Weight of water, salt and fibre	150
Weight of packing & utensils	50
Weight of food	750
Weight of nutrients	600

Macronutrient	Recommended % contribution to total energy	kJ/g	g	kJ	% energy
Protein	15	17	100	1700	15
Fat	20	37	65	2405	21
Carbohydrate	65	17	435	7395	64
		Total	**600**	**11500**	**100**

Note: Assuming 200 kJ is derived from the dietary fibre, total available energy (kJ) in the LWRP would be 11.7 MJ.[28]

Figure 2. 72-hour LWRP items

5.2 Hot-climate ration pack (HCRP)

Whether or not rations are eaten depends on many factors; weather conditions in particular can affect what and how much is eaten. As the ADF often trains and operates in hot climates, a prototype hot-climate ration pack (HCRP) was developed (Figure 3).[27] It was based on the CR1M with selected items replaced by others assessed to be more acceptable in hot climates (Table 6). For ease of development, the new items were readily-available commercial products but care was taken to ensure the size, weight and nutritional value matched those of the CR1M. Field trials in 2008 comparing this HCRP to CR1M showed that fewer of the food and beverage items of the HCRP were discarded.

Table 6. Three menus developed and tested as prototype HCRP[29]

MENU A					
*chicken with vegetables	1x175 g	sports beverage tropical (1 L)	1x70 g	*original jerky pieces	1x25 g
*fruit muesli mix	1x60 g	sweet chilli sauce	1x10 g	canned peaches	1x140 g
skim milk powder	2x3 g	*dried apricots	1x50 g	*fruit mentos	1x38 g
*original muesli bar	1x45 g	*honey roasted nuts	1x50 g	jam sandwich biscuit	1x45 g
*BBQ shapes	1x25 g	*teriyaki jerky bar	1x25 g	*chocolate protein bar	1x65 g
*sports pouch berry	1x25 g	*chocolate protein drink	1x50 g	*cola sports gel	1x25 g
MENU B					
BBQ beef	1x250 g	sports beverage mixed berry (1 L)	1x70 g	*original jerky pieces	1x25 g
*almond & sesame muesli bar	1x40 g	tomato & basil tuna #	1x85 g	canned two fruits	1x140 g
*Ski D'lite muesli bar	1x24 g	*Pizza Shapes	1x25 g	*Skittles	1x55 g
*Trail Mix	1x25 g	sweet chilli sauce #	1x10 g	*fruit pastilles	1x52 g
*tortilla bread	1x54 g	*teriyaki jerky bar	1x25 g	Scotch Finger biscuit	1x35 g
*sports pouch lemon/lime	1x20 g	*vanilla protein drink	1x80 g		
MENU C					
beef minced with tortellini	1x250 g	sports beverage grape (1 L)	1x70 g	*original jerky pieces	1x25 g
tropical fruits muesli bar	1x33 g	tomato sauce #	1x10 g	canned pears	1x140 g
*almond nuts	1x50 g	*cookie flavour protein bar	1x40 g	*orange sports beans	1x28 g
*cereal bar	1x35 g	*sultanas	1x50 g	*Mint Mentos	1x37.5 g
*Cheddar Shapes	1x25 g	*pepper jerky bar	1x25 g	*Tiny Teddy biscuits	1x25 g
*sports pouch pineapple	1x20 g	*chocolate protein drink	1x80 g	*ham and potato	1x175 g
				*cola sports gel	1x25 g

Additional Food Items Common to all HWRP Menus					
Cracked Pepper Vita Wheat	1x36 g	instant coffee	1x3.5 g	tea bags#	1x2.5 g
cheddar cheese (canned)	1x56 g	cappuccino beverage	1x12 g	Vegemite#	1x15 g
sweetened condensed milk	1x85 g	black pepper	1x2 g	chocolate ration	1x50 g
sugar	4x7 g	salt	1x2 g	chewing gum#	1x2.7 g
Non-Food Items Common to all HWRP Menus #					
plastic, resealable bag (water/food)	1 Only	menu sheet –	1 Only	ingredients sheet	1 only
plastic inner bag (sundry)	1 Only	components	1 Only	nylon scouring pads,	1 only
rubber bands, size 32	2 Only	can opener, (Fred)	1 Only	plastic spoon	1 only
rubber bands, size 62	1 Only			toilet paper, 2 ply, 10 sheet	1 Pkt
Note: : All items start with * are new or commercial items; others are from CR1M (06/07)					

Figure 3. Hot-climate ration pack items.[27]

5.3 Modularised Ration Packs (ModRP)

CRP could be modularised with respect to types of foods and beverages included, packaging requirements, shelf-life, preparation required or amount of energy delivered. The last of these is currently of particular interest as it provides a basis for better matching ration packs to the estimated PAL for the operations being undertaken. A prototype Modular Energy System (MES) ration pack was developed with a base module tuned for light activity and one or two supplementary modules to be added depending on whether the operations are at a moderate or high activity level (Figure 4). Details of the two menus developed are given in Table 7. The modularisation of CRP offers the opportunity to tailor rations in the field to the Physical Employment Standards (PES) currently being investigated by Army and DSTO.

Figure 4. Modular ration pack trialled.[29]

Table 7. Details the two menus developed.[29]

Standard Provision → **Base Modules**

Variety A	Serve Size (g)		
Retort Meal Chilli Con Carne	1	x	250
Instant Oriental Noodles	1	x	74
Grain Snacks Cheddar and Chives	1	x	20
Carmans Muesli Bar Original	1	x	45
Yoghurt Top Muesli Bar, Strawberry	1	x	31.3
Peaches in Syrup	1	x	140
Fruit & Nut Mix	1	x	60
Ration Chocolate	1	x	50
Skittles	1	x	55
Milo Drink Powder	1	x	20
Endura Lemon Lime Drink	1	x	25
Flat bread (Naan)	1	x	70
Mentos	1	x	37.5

Variety B	Serve Size (g)		
FD Meal Veal Italienne	1	x	110
White Rice	2	x	125
Honey & Oat Slice, Lots of Fruit	1	x	80
Yoghurt top Muesli Bar, Apricot	1	x	31.3
Two Fruits in Syrup	1	x	140
Fruit & Nut Mix	1	x	65
Grain Snacks Sea Salt	1	x	20
Ration Chocolate	1	x	50
Starburst Fruit Chews	1	x	58
Milo Drink Powder	1	x	20
Endura Lemon Lime Drink	1	x	25
Flat bread (Naan)	1	x	70
Mentos	1	x	37.5

Add 1, 2 or 3 modules according to workload → **Energy Modules**

Energy Step 1	Serve Size (g)
Fruit & Nut Mix	1 x 65
Bulk Protein Bar	1 x 80
Winners Energy Gel Lemon and Lime	1 x 40
Grain Snacks Cheddar and Chives	1 x 20
Endura Lemon Lime Drink	1 x 25

Energy Step 2	Serve Size (g)
Flat bread (Naan)	1 x 70
Carmans Muesli Bar Classic	1 x 45
Fruitip Pastilles	1 x 34
Pasta Tuscan Tomato	1 x 200
Endura Lemon Lime Drink	1 x 25

Energy Step 3	Serve Size (g)
Skittles	1 x 55
Basmati Rice	2 x 125
Tuna, Lemon and Black Pepper	1 x 100
Beef Jerky Pieces, Teriyaki	1 x 25

Standard Provision → **Ancillaries**

	Serve Size (g)
Beverage, coffee, instant	2 x 3.5
Beverage, tea bags	2 x 2.5
Sugar	4 x 7
Dried Skim Milk	2 x 3
Sweetened Condensed Milk	1 x 85

5. Closing Comments

Napoleon Bonaparte remarked that an Army marches on its stomach; today we know that soldiers think and fight better if properly fed. Modern combat rations in the form of convenient, pre-packaged meals largely solve the problem of feeding soldiers during military operations where field kitchens and messes cannot be used. Further development and improvement continues with effort now being directed to tailoring the energy and macronutrient content, improving micronutrient balance and increasing palatability and acceptance.

Today we also have a good understanding of the dietary needs of military personnel and how these vary with the nature of the activities undertaken, the climate and other conditions under which they operate. We are also able to take into account the less tangible 'human preference' effects of taste, appearance, convenience and societal eating norms when developing combat rations. This can help to better define combat ration pack requirements and specify their components.

Nutrition and food science may not receive the level of attention afforded many other areas of Defence S&T, for example autonomous vehicles, smart munitions and space-based surveillance. However, combat rations remain vital to the cognitive and physical performance of our soldiers in the field. Continued research in Defence food and nutrition sciences, and development of new CRP prototypes, is providing the ADF with combat rations that deliver the best possible nutrition for sustained cognitive and physical performance over the spectrum of operations undertaken.

6. Acknowledgments

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19. ABSTRACT

The introduction of continual product improvement—whereby items are replaced or reformulated depending on feedback from soldiers and sensory evaluation of specific foods and beverages—has led to a steady improvement in both the nutritional quality and acceptability of combat rations. In addition, prototype ration packs have been developed for specific purposes and include light-weight rations, hot climates rations, and modular rations. Combat rations remain vital to the performance of our soldiers during training, on field exercises and on operations. Continued research in Defence food and nutrition is essential to ensure that ADF members are provided with combat rations that deliver the nutrition required to sustain optimal cognitive and physical performance.